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Effects of Virtual Product Development on Product Quality

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Overview

- Setting the scope
- Virtual Product Development & Product Quality: a problem?
- Research Objectives, Research Questions
- Research Results
- Application in Industry
- Discussion / Questions

Setting the scope

Trend:

OEMs increasingly investigate opportunities for product development in close cooperation with suppliers

Reasons:

- Focusing on core activities
- Strengthening of innovative capabilities
- Reduction of costs/TTM
- Instant access to state-of-the-art technology & knowledge
- Mitigation of product risks
- …

Consequence:

Products are being developed by separate parties across multiple disciplines at separate geographical locations (*virtual product development*, a.k.a. *distributed*, *multi-site* or *global development*). Typically applied in the development of *complex products*.

Virtual Product Development - 1

Virtual Product Development (VPD) is the development of a product by a virtual team

A virtual team is a team distributed across space, time, and/or organisational boundaries, working interdependently with a shared goal and collaborating by webs of interactive technology.

[Lonchamp, 2002; Gibson et al, 2003]

VPD shows a worldwide, strongly increasing trend

[Carmel, 1998; Carmel & Tjia, 2005]

Virtual Product Development - 2

VPD is much more complex than ‘co-located’ development

In terms of:

- Geographic dispersion
- Control & coordination breakdown
- Loss of communication richness
- Loss of teamness
- Cultural differences

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“One of the biggest mistakes is that senior management does see the profits of collaboration, but seems to neglect the consequences for ‘the working floor’.

Strategy-wise everything is OK, but not at the operational level; the rest of the organisation is not yet capable (or not yet trained) to collaborate, to look beyond the borders of the own organization.

Now it is often assumed just by default that the other organizations will work in a similar fashion”

[“Building Innovation”, June 2007]

What is a Complex Product? - 1

A product or system consisting of multiple components that combines the technical capabilities of multiple engineering disciplines to fulfil its intended use

What is a Complex Product? - 2

Typical characteristics of ‘Complex Products’:

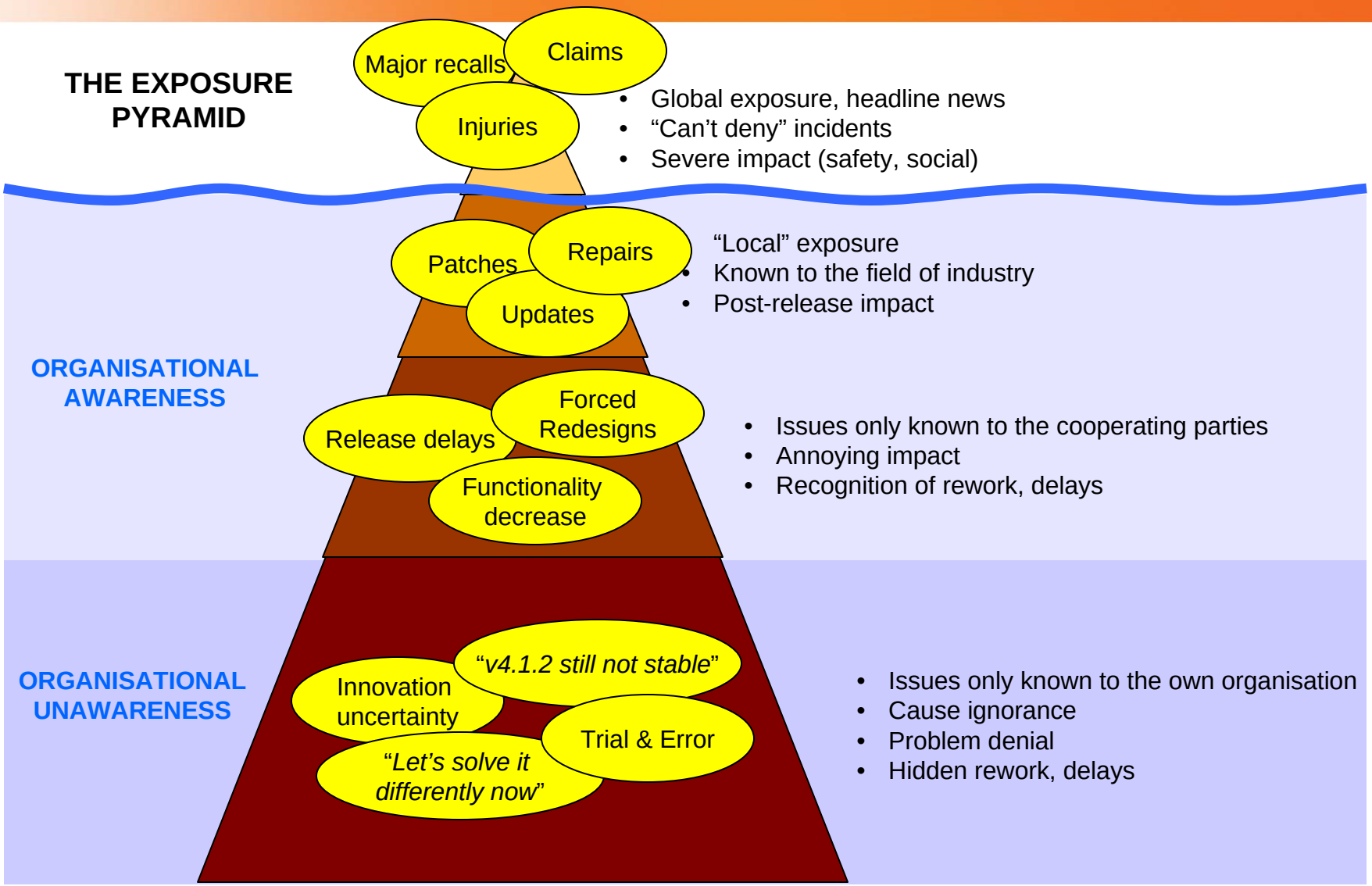
- Contain ‘in-product’ software
- Components stem from multiple engineering disciplines
  - mechanics, hardware
  - software
  - physics, opto-electronics
- Developed by multiple parties at multiple sites
- Often user-control (UI)
- Heavy internal/external interfacing
- Control of complex hardware components
- Often hardware under continuous development
- Strong real-time aspects often involved

Observations from industry study

- Focus primarily on effects of VPD on managerial aspects: delivery on time, within budget
- Cultural differences and collaboration receive lots of attention
- Many experience reports, suggesting solution directions
- Occasionally attention to specific development processes (e.g. requirements engineering, configuration management)

- However, effects on product quality are hardly addressed, despite:
  - Evidence of adverse effects of VPD on product quality
  - Strategic importance of product quality (maintenance costs, company market profile, lawsuits, product recalls)

Perception of Quality Problems



Research objectives

FACT 1:

Organizations have never been very keen on disclosing their negative experiences with product quality:

"companies are extremely reluctant to provide or publish data on defects"

[N. Fenton, 1996]

"organizations are even more reluctant to provide quality data than to provide effort data"

[S. Chulani, 1999]

"release of software failure data has been equated to embarrassment"

[P. Dapena, 2002]

"project data is mostly transparent; the fog only gets in when it comes to design details and quality data"

[J.H. van Moll, 2006]

FACT 2:

"Near-misses" in Product Quality
are never documented !!

Research questions

- What typical problems with product quality occur?
  - Analysis of quality problems in 22 VPD projects across 4 product domains (18 companies)
- What are typical causes of those problems in VPD?
  - Identification of VPD-specific defect causes by teams of experts
- Can product quality problems in VPD be prevented?
  - Estimation of the number of preventable defects in a specific situation
- Identification of factors influencing defect introduction (DI) and defect detection (DD)
  - Identification, grouping, relative importance

Research questions

- What typical problems with product quality occur?
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-
  - (DD)
    - Identification, grouping, relative importance

Note that VPD is **not necessarily** about teams globally distributed, across multiple organizations, or multiple disciplines:

Two separate development teams of the same company on a single site might experience product quality problems similar to those by a globally distributed team.

Research results - 1

Product quality problems occur, specifically caused by the characteristics of VPD

60% of total nr. of quality problems relates to VPD

23 problem types across 5 major problem areas

Configuration Management

Test Strategy

Requirements Management

System/Product Integration

Test Environment

Project management keeps implementing development and testing practices the ‘traditional way’

Product quality problems can be prevented by taking into account the effects of distributed development on product quality (preventable defects 52% of total nr.)

Typical problem examples

- (System) integration problems
  - Lack of strategy
  - Blocking issues / delays
  - Integration testing forcedly cancelled/skipped
- (System) testing problems
  - Test coverage shortcomings (blind spots / overtesting / overreliance)
  - Misalignment of test objectives / strategies
  - Absence / misinterpretation of test results & reports
- Product requirements
  - Misinterpretation / misimplementation / implementation duplicates
  - Unsuitable as test basis
  - Documentation white-spots
- Configuration management
  - Change control problems
  - Version control problems
- Test environment
  - Non-availability
  - Lack of representativeness

Generally causing:

- **Increase of defect introduction**
- **Decrease of defect detection**

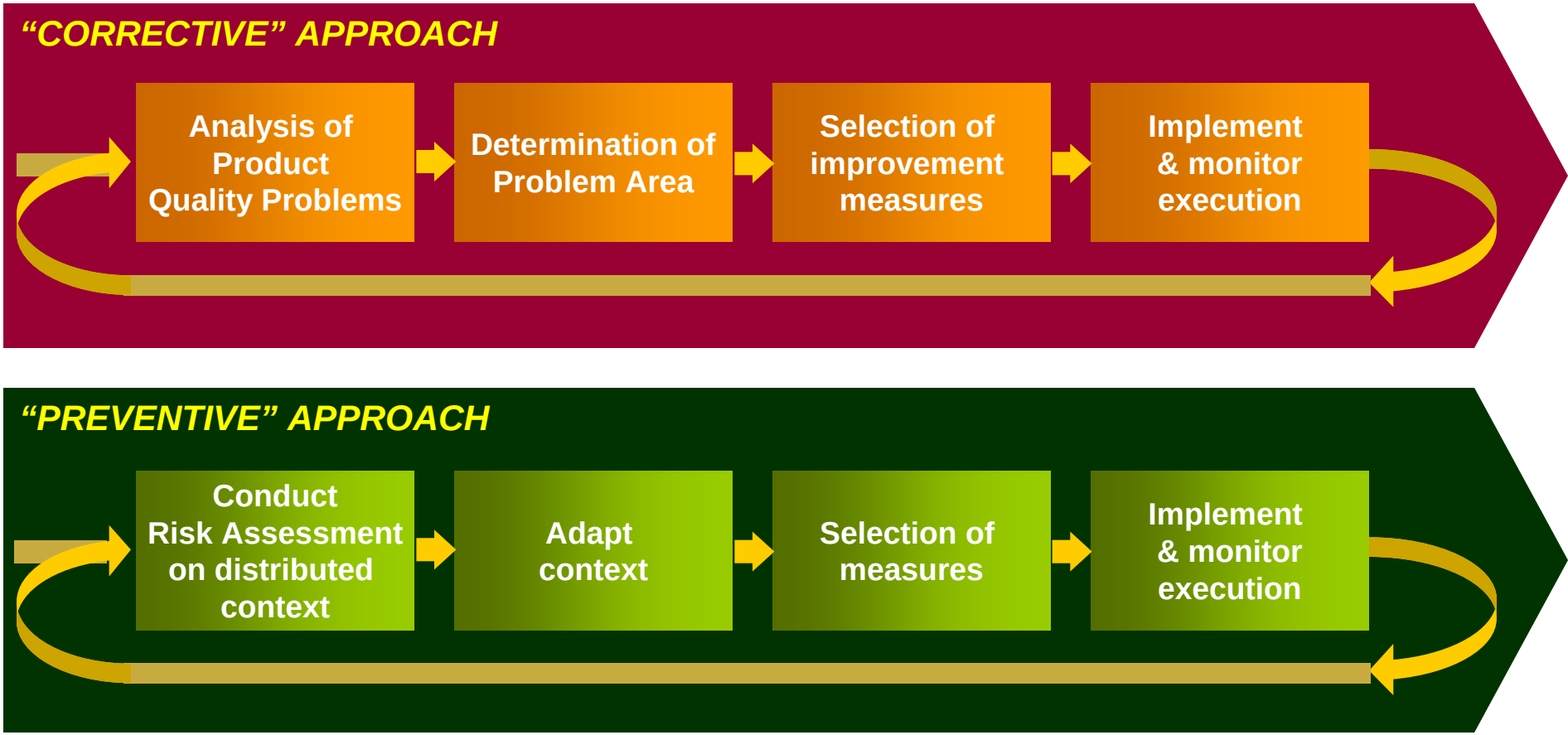
Research results - 2

Defect Introduction Factors	
1	Requirements
2	Developer Capability
3	Domain Knowledge
4	Communication
5	Product Complexity
6	Change Control
7	Project Management Maturity
8	Quality of Documentation
9	Team Composition
10	Development Environment
11	Collaboration
12	Process Maturity
13	Business Management Maturity
14	Innovation
15	External Disturbance
16	Team Distribution

Defect Detection Factors	
1	Test Capability
2	Quality of Documentation
3	Management Attitude
4	Test Process Maturity
5	Testability
6	Communication
7	Test Environment
8	Product Complexity
9	Change Control
10	Development Process Maturity
11	Test Planning
12	Product Integration
13	Test Team Organization
14	Adherence to Plan
15	Support for Testing
16	Test Team Cohesion
17	Team Distribution

Solution Directions

Factor-based assessment and improvement of development and test practices in distributed projects



Summary

- VPD does have adverse effects on product quality
  - if organizational focus w.r.t. collaboration is too heavy on ‘strategy’, instead of on ‘operations’

- Potential adverse effects can be prevented or minimized
  - Early defect detection and prevention in distributed contexts
  - Higher (and known!) product quality
    - Visibility of quality data from 45% to 68% (actual)
    - Additionally, increased control of costs and schedule
  - Decrease in number of product defects
    - 52% of total number of problem reports (estimate, @ system test level)
  - Decrease of project lead times
    - ≈ 30% (estimate)
  - Decrease in number of integration issues
    - 39% (actual)

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QUESTIONS ?

Second thoughts? Need more information? Please contact either ‘jan.van.moll@sioux.eu’ or ‘jef.jacobs@nxp.com’

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